

THE
BOTANICAL GAZETTE

FEBRUARY 1918

ALGAE OF THE HAWAIIAN ARCHIPELAGO. II

VAUGHAN MACCAUGHEY

The following list will indicate the specific content of the alga flora of the Hawaiian Archipelago. In so far as has been possible to obtain published records, in addition to the author's material, the list comprises practically all known Hawaiian algae. As the field has never been intensively surveyed in its entirety, there is undoubtedly a vast number of forms still undescribed. This is particularly true of the phytoplankton. The list includes brief characterizations, with special reference to habitat and geographical distribution. Items of special interest, such as economic uses, are also noted, although it has been necessary to restrict such data sharply for sake of compactness. The list is offered as a reconnaissance, and carries no implication of completeness.

The sequence of families is that of ENGLER and PRANTL; the sequence of species is that of DETONI (*Sylloge Algarum*). The determinations are principally those of TILDEN, LEMMERMANN, REED, and SETCHELL; in many cases material collected by the author has been compared with the original descriptions, and the representative stations or habitats have been confirmed, redefined, or extended. The literature concerning the habitats and ecological relations of Hawaiian algae is very scanty; the chief aim of the present paper has been that of summarizing available data, and thus indicating the need for more detailed and intensive investigations.

Schizophyceae

CHROOCOCCACEAE

Chroococcus turgidus (Kuetz.) Naegeli.—In shallow stagnant pools; collected on the slopes of Mauna Kea, Hawaii.

C. macrococcus (Kuetz.) Rabenh.—In shallow stagnant pools; collected on the slopes of Mauna Kea, Hawaii.

Gloeocapsa polydermatica Kuetz.—Plant colony gelatinous and slimy; dull green or dusky olive, often very dark; on wet cliffs and rock surfaces; from sea level up through the rain forests.

G. quarternata (Breb.) Kuetz.—Forms a gray-green or light olive mucilaginous coating on wet cliffs; abundant in the humid zones, especially near waterfalls.

G. magma (Breb.) Kuetz.—Forms a grumous, crustaceous, coppery purple mass on wet stones, in and along mountain streams, mostly between 1000 and 6000 ft.

G. thermalis Lemm.—Colonies mucous, hyaline or dark purple; characteristic of warm pools on Hawaii, especially in the Puna district.

Chondrocystis Schauinslandii Lemm.—Colony cushion shaped, widely expanded, up to 35 cm. high, cartilaginous, soft and fragile, incrustated with lime at the base; recorded only from the Laysan Island lagoon.

Gloeotheca fuscolutea Naegeli.—Colonies soft, gelatinous, bright blue-green, often covering the surface of the water in the lowland rice fields and among taro patches (loi).

Aphanothece Naegeli Wartmann.—Colonies gelatinous, forming small, soft, olive-brown lumps along the margins of waterfalls, among mosses, liverworts, etc., in the rain forests and on wet cliffs.

A. prasina A. Braun.—Colonies soft, gelatinous, more or less globular; bright emerald green; forming free swimming, tuberculose, globose, or flattened masses; floating in brackish water in stagnant pools, rice patches, and similar situations.

Gomphosphaeria aponina Kuetz.—Colonies spherical, mucous, solid, and free swimming; collected among marine algae at Laysan Island.

Coleosphaeriopsis halophila Lemm.—Colonies spherical, gelatinous, hollow, known only from the lagoon of Laysan Island.

Merismopedium glaucum (Ehrenb.) Naeg.—Colonies flat, free floating, in shallow, sluggish water, such as rice fields, taro loi, etc.; sometimes very abundant, especially in late summer (Oahu).

CHAMAESIPHONACEAE

Xenococcus laysanensis Lemm.—Epiphytic, disk-shaped colonies; collected on marine algae at Laysan Island.

X. Kernerii Hansg.—Colonies irregularly expanded, crustaceous; fairly abundant in ditches and taro patches throughout the lowlands; sometimes epiphytic.

Chamaesiphon curvatus Nordst.—Epiphytic; collected among filaments of *Cladophora longiarticulata* in taro patches and ditches; not common; var. *elongatum* Nordst. is found in similar situations.

OSCILLATORIACEAE

Oscillatoria sancta Kuetz.—Colonies or plant mass dark lead colored, "becoming violet when dried and tinting the paper a beautiful violet" (TILDEN); forms a reddish brown or grayish skin on the wet sides of cliffs, waterfalls, ditches, and other moist, earthy places.

O. Bonnemaisionii Cruan.—Trichomes form loose and regular spirals; epiphytic on marine algae in Laysan Island waters; mixed with other algae, floating in lagoons within the reefs, Hawaii and other islands.

O. corallinae Gomont.—Trichomes gregarious, forming a fine, delicate coating on the surface of larger algae; collected at Laysan in washings from marine algae.

O. laetevirens Crouan.—Plant mass thin, membranaceous, bright blue-green; abundant, forming a delicate stratum covering the bottoms and sides of tidal pools in rocky places along the platform reefs; also collected among washings from marine algae at Laysan.

O. formosa Bory.—Plant mass dark blue-green; common on wet cliffs and near waterfalls, in the montane rain forests; also on the walls of wet caverns, near the mouths; these latter situations are often rich in blue-green algae.

Trichodesmium Thierbaultii Gomont.—Colonies green, forming extensive disconnected “sea blooms”; collected in plankton between Hawaii and Laysan.

T. contortum Wille.—Colonies bright yellow, spirally twisted; habit like the preceding; collected in plankton between Hawaii and Laysan.

Spirulina major Kuetz.—Plant mass dark blue-green; usually scattered among other algae, as on the sides of wet cliffs and near the mouths of the very numerous moist caverns or “lava-tubes” which honeycomb the Hawaiian mountains, from sea level to the highest summits.

S. subtilissima Kuetz.—Plant mass mucous, dark green; collected at Laysan Island in washings from marine algae.

Phormidium Crosbyanum Tilden.—Plant mass 2 cm. thick by 5 cm. diameter, impregnated with lime, somewhat hard, bluish green to reddish brown; forming flattened globose cushions on rocky shelves along the coral reefs and ledges, between tide marks.

P. papyraceum (Agardh) Gomont.—Plant mass expanded, glistening, thin, leathery, dark green; on wet rocks and cliffs, and around water-tanks, troughs, flumes, etc.; abundant.

P. laysanense Lemm.—Known only from Laysan Island, where it was collected on *Turbinaria*.

P. favosum (Bory) Gomont.—Plant mass moderately expanded, papery or thick, attached at base, floating; on sides and bottoms of irrigation ditches and troughs, tanks, etc.; not uncommon.

Lyngbya mucicola Lemm.—Epiphytic; known only from Laysan Island, where it was collected on *Chondrocystis Schauinslandii*.

L. rivulariarum Gomont.—Occurring in masses of *Nostoc*, in lowland ditches and taro patches; not uncommon.

L. subtilis W. West.—Filaments solitary and scattered; in pools and ditches in the lower zones of the larger islands.

L. distincta (Nordst.) Schmidle.—In irrigation ditches and streams; fairly plentiful; also found among the filaments of such other algae as *Pithophora* spp.

L. cladophorae Tilden.—Epiphytic on filaments of *Cladophora*, in the mountain streams.

L. Meneghiniana (Kuetz.) Gomont.—Plant mass up to 1 cm. high; caespitose, fasciculate, mucous, dull blue-green; collected on marine algae at Laysan; not known from the other islands.

L. semiplena (C. Agh.) J. Agh.—Plant mass rarely higher than 3 cm., caespitose, extensive, mucous, usually dull yellowish green or dark green; occurs in the rocky basins of tidal pools along the platform reefs of such islands as Oahu and Kauai; also collected on marine algae at the Laysan atoll.

L. confervoides C. Agh.—Plant mass 5 cm. high, caespitose, extended, fasciculate, mucous, dull yellowish or dark green; fairly common on rocky shores and in tidal pools.

L. aestuarii (Mertens) Liebman.—Plant mass widely extended, either forming a compact woolly layer on moist earth, or a floccose mass floating in water, blackish or dull blue-green; common in ditches and muddy taro patches, forming a skin over the substratum; also on sandy beaches.

forma *natans* Gomont.—Plant mass covered with water; at first attached to wet earth, later floating; filaments loosely entangled; floating in fresh water lagoons, rice fields, taro patches, etc.

forma *aeruginosa* (Agh.) Wolle.—Plant mass dark blue-green; forming conspicuous patches in shallow water of rice fields, taro patches, and similar situations.

L. majuscula (Dillwyn) Harvey.—Plant mass up to 3 cm. high or long; widely expanded; dark blue to yellowish green; filaments very long; epiphytic on other marine algae, in shallow waters along the coral reefs.

L. Martensiana Menegh.—Plant mass caespitose, blue-green; occurring on twigs, etc., under dripping water, under flumes, and tanks, and near waterfalls in the mountains; not uncommon.

L. perelegans Lemm.—Epiphytic; known only from Laysan Island, where it was collected on other marine algae.

L. Kuetzingii var. *distincta* (Nordst.) Lemm.—Occurs on the lowlands, in ditches and shallow ponds; epiphytic on such forms as *Pithophora* and *Cladophora*.

Hydrocoleus cantharidosmus (Mont.) Gomont.—Plant mass up to 2 cm. high, caespitose, slippery, olive or dark blue-green; growing with other algae in shallow waters along the coral reefs and beaches.

Inactis hawaiiensis (Lemm.) DeToni.—Filaments solitary, growing in a gelatinous mass formed by other algae; collected in warm pools on the Island of Hawaii, in company with *Gloeocapsa*, *Stigonema*, etc.

Microcoleus paludosus (Kuetz.) Gomont.—Filaments entangled, growing among other algae or forming a blackish or blue-green stratum; together with other algae it forms a layer covering rocks on the bottoms and sides of the "Green Lake" in Puna, Hawaii.

Catagnymene pelagica Lemm.—Unicellular, free floating filaments; collected in plankton between Hawaii and Laysan.

C. spiralis Lemm.—Habitat as for the preceding species; collected in plankton between Hawaii and Laysan.

Haliarachne lenticularis Lemm.—Filaments multicellular, free floating in globose or elongate colonies; collected in plankton between Hawaii and Laysan.

NOSTOCACEAE

Nostoc punctiforme (Kuetz.) Hariot.—Colonies small, globose, scattered or confluent; frequent on the wet walls of ditches and taro patches.

N. paludosum Kuetz.—Colonies very minute, scarcely visible, punctiform, gelatinous; in shallow ditches and pools.

N. Linckia (Roth) Bornet.—Colonies of various sizes, finally clathrate-fenestrate and irregularly torn, blue-green or violet; occurs with *Conferva sandwicensis* and other algae in shallow pools, taro loi, swampy places, etc., at low altitudes.

N. piscinale Kuetz.—Fairly abundant in late summer in rice fields, taro patches, irrigation ditches (au-wai), etc.

N. spongiaeforme Agardh.—Colonies at first minute, finally expanded, verrucose, bullose; in taro patches and other warm, shallow, muddy bottomed waters; fairly plentiful.

N. foliaceum Mougeot.—Colonies gelatinous, spongy, lacunose; in globules among mosses and liverworts on wet cliffs in the montane rain forest zone, and in the vicinity of waterfalls; not recorded from the lowlands.

N. commune Vaucher.—Colonies spreading out as undulating, folded, fleshy, torn or perforated sheets, leathery on the surface;

common around water troughs, tanks, flumes, and similar moist situations.

N. verrucosum (Linn.) Vaucher.—Colonies often gregarious, up to 10 cm. in diam.; at first solid, gelatinous, firm, spherical, later hollow and torn; forming small, black-green, shotlike balls, covering the sides of pools in falls and rapids of the streams in the montane rain forests; not uncommon.

Nodularia hawaiiensis Tilden.—Plant mass or colony stringy, dark green, in tufts along the outer margins of the coral reefs; constantly washed by the surf; fairly common.

Anabaena variabilis Kuetz.—Colonies gelatinous, spreading on damp soil or floating free, dark green; on bottoms and sides of irrigation ditches, taro patches, and other moist places; this, like the following species, is usually found in connection with other algal forms.

A. catenula (Kuetz.) Born. and Flah.—Colonies gelatinous, floating, blue-green; frequent in stagnant water of rice fields and taro patches; sometimes in mountain streams, but not recorded from high altitudes.

A. confervoides Reinsch.—Colonies thin; floating in taro patches and other shallow water; sometimes rather abundant, but usually rare.

Cylindrospermum stagnale (Kuetz.) Born. and Flah.—Colonies floccose, expanded, indefinite, mucous; attached or floating; on wet cliffs and in the vicinity of waterfalls, chiefly in the rain forests.

C. catenatum Ralfs.—Colonies mucous, orbicular-confluent, indefinite, blackish green; along the mountain streamways, on rocks and wet cliffs; abundant in certain localities.

Richelia intracellularis J. Schm.—Endophytic, with single trichomes; found living in the cells of *Rhizolenia styliformis* and *Hemiaulis delicatus*; collected in plankton between Hawaii and Laysan.

Aulosira Schauinslandii Lemm.—Filaments free and equal; scattered or fasciculate; collected on *Turbinaria* at Laysan.

Michrochaete vitiensis Askenasy.—Colonies loosely caespitose, short, tomentose; collected growing on *Liagora coarctata* at Laysan.

Hormothamnion solutum Born. and Grunow.—Plant mass floccose, entangled, mucous, green or blue-green; not uncommon here and there along the coral reefs, in shallow waters and in tidal pools.

SCYTONEMACEAE

Plectonema nostocarum Bornet.—Filaments graceful, elongate, at first much branched, later sparingly branched; collected in warm pools in the vicinity of Kilauea Crater, an active volcano on the island of Hawaii.

Scytonema rivulare Borzi.—Colonies widely extended, woolly, blackish, tending toward reddish or brown; forming dark brownish or purple-red cushions on stones in the mountain streams; plentiful.

S. crispum (Agh.) Bornet.—Colonies caespitose, entangled, woolly, green, becoming brown or olive; in ponds, rice fields, taro patches, and other quiet or stagnant waters on the lowlands.

S. azureum Tilden.—Cell contents deep purple-blue; with other thermophilous algae forming a layer covering rocks on the bottoms and sides of hot springs in the Puna district, Hawaii.

S. varium Kuetz.—Colonies 2–3 mm. high, cushion-shaped, bluish green or brownish; often found on wet cliffs near waterfalls, chiefly in the rain forests.

S. javanicum (Kuetz.) Bornet var. *hawaiiensis* Lemm.—Colonies cushion-shaped, dark blue-green; collected among the wet mosses, etc., in the forests near Kilauea Crater, Island of Hawaii.

S. ocellatum Lyngb.—Colonies cushion-shaped, black or gray, becoming bluish; on moist shaded rocks and wet cliffs.

S. guyanense (Montagne) Born. and Flah.—Colonies dense, cushion-shaped, 1–2 mm. thick, widely expanded, blackish green; on moist stones.

S. mirabile (Dillwyn) Born.—Colonies woolly, widely expanded, spongy tomentose, brownish black or blackish green; collected in shallow pools on the slopes of Mauna Kea, Hawaii.

S. fuliginosum Tilden.—Colonies thin, bluish green; forms thin layers on the bottoms of shallow tidal pools, along the platform reefs and rocky shores; fairly common.

Tolypothrix lanata (Desv.) Wartmann.—Colonies caespitose-floccose, blue-green, becoming brownish with age; found in shallow

stagnant pools on the slopes of Mauna Kea, adhering to leaves, etc., in the water.

T. distorta (Hofman-Bang) Kuetz.—Colonies caespitose-floccose or cushion-like, blue-green or brownish; forming tufts or cushions on stones in the mountain streams; plentiful in the montane rain forest zone.

STIGONEMACEAE

Hapalosiphon fontinalis (Agh.) Bornet.—Colonies dull blue-green, 3 mm. high; found in shallow stagnant pools on Mauna Kea, adhering to leaves and other litter.

Fischerella ambigua (Naeg.) Gomont.—Colonies crustaceous, orbicular, up to 1 mm. thick, brown becoming black; on moist soil on shady places, on the lowlands, and in the rain forests.

F. thermalis (Schabe) Gomont.—Colonies 0.5 mm. thick, cushion-shaped, woolly, expanded, blackish olive or blue-green; collected in warm pools in the vicinity of Kilauea Crater.

var. *mucosa* Lemm.—Habitat as for the species; luxuriant algal growths occur in these warm springs.

Stigonema aerugineum Tilden.—Colonies forming a brown, membranous layer on the bottoms of shallow quiet pools.

S. ocellatum (Dillwyn) Thuret.—Colonies cushion-shaped, woolly, brownish; frequent in quiet shallow pools.

S. minutum (Agh.) Hassall.—Colonies crustaceous or cushion-like, thin, fragile, blackish; collected on moist stony soil in the vicinity of Hilo, Hawaii.

RIVULARIACEAE

Calothrix confervicola (Roth) Agh.—Filaments gregarious, stellately fasciculate, attached, rigid; collected as epiphytes on marine algae, at Laysan.

C. aeruginea (Kuetz.) Thuret.—Filaments forming a somewhat continuous light blue-green layer on the surfaces of larger algae; common in tidal pools along the coral platforms and rocky shores.

C. crustacea Thuret.—Colonies caespitose, velvety, widely expanded, blackish green or brownish; epiphytic on other algae in tidal pools and along the reefs.

C. fusca (Kuetz.) Bornet and Flah.—Filaments scattered or gregarious; living within the colonies of various gelatinous algae; in ditches, taro patches, and rice fields.

C. sandvicensis (Nordst.) Schm.—Epiphytic on filaments of *Pithophora affinis*, in shallow water on the lowlands.

C. rhizoleniae Lemm.—Epiphytic on *Rhizolenia* and *Hemiaulus*; collected in plankton between Hawaii and Laysan.

Rivularia natans (Hedwig) Welwitsch.—Colonies spherical, hollow, soft, dull olive-green; forming soft brown velvety masses, in rice fields and taro patches; common on the lowlands.

Chlorophyceae

SPHAERELLACEAE

Haematococcus pluvialis Flotow.—Occurs throughout the islands in shallow pools and streams, often forming reddish patches; it is a cosmopolitan species.

H. thermalis Lemm.—Abundant in the warm springs of the Puna district, Hawaii, and endemic to this region.

VOLVOACEAE

Gonium sociale (Duj.) Warm.—Occurs in ponds, taro patches, etc., throughout the islands.

Other well known genera, such as *Volvox*, *Pandorina*, and *Eudorina*, have not been reported as yet from the islands.

TETRASPORACEAE

Dactylococcus infusionum var. *minor* Nordst.—A widely known species, frequent in streams and shallow waters.

Dictyosphaerium pulchellum Wood.—A fairly common species.

PLEUROCOCCACEAE

Gloeocystis gigas (Kuetz.) Lagerh.—Has been recorded from the swamps on the middle slopes of Mauna Kea, Hawaii.

Raphidium polymorphum Fres.—A cosmopolitan species; occurs throughout the islands in fresh waters.

Schroederia setigera Lemm.—In pools and streams.

Closteriopsis longissima Lemm.—In pools and streams.

Oocystis Naegeli A. Br.—Has been collected in swamps on the middle slopes of Mauna Kea, Hawaii.

Scenedesmus quadricauda (Turp.) Breb.—In pools and reservoirs on all the islands; var. *oahuensis* Lemm. has been collected on the lowlands of Oahu.

CHARACIACEAE

Characium ensiforme Herm.—Has been reported from the swamps on the slopes of Mauna Kea.

C. minutum A. Br.—In wet caverns and other moist habitats.

C. groenlandicum Richter.—Found growing on crustaceans in fishponds on the island of Molokai.

HALOSPHAERACEAE

Halosphaera viridis var. *gracilis* Lemm.—Collected in plankton between Hawaii and Laysan.

HYDRODICTYACEAE

Pediastrum integrum var. *Braunianum* (Grun.) Nordst.—Pools and streams.

P. Boryanum (Turp.) Menegh.—Pools and streams.

P. duplex var. *clathratum* A. Br.—Pools and streams; var. *reticulatum* Lagerh. occurs in the same habitats.

P. tetras (Ehrenb.) Ralf.—Pools and streams.

P. bidentulum var. *ornatum* Nordst.—Stagnant shallow waters.

Hydrodictyon reticulatum (L.) Lagerh.—Plentiful in rice fields, taro patches, and other shallow waters; it is called *pala-wai* by the native Hawaiians, and sometimes used by them for food. The native name is also applied to several other green fresh water algae.

OPHIOCYTIACEAE

Ophiocytium gracilipes A. Br.—A free swimming form, in shallow waters, and also in wet caves at higher levels.

CONFERVACEAE

Conferva bombycina var. *minor* Wille.—Cosmopolitan.

C. sandwicensis Agh.—Endemic; in rice fields, pools, and streams; filaments very fine and silky.

ULVACEAE

Monostroma spp.—Several unidentified species occur in brackish pools and lagoons along the reefs.

Ulva rigida Agh.—Occurs along the coral reefs of the larger islands and also the atolls.

U. fasciata Delile.—Thallus stipitate, simple or divided into acute segments; fairly common along coral reefs and beaches.

U. lactuca L. forma *genuina* Hauck.—This and var. *laciniata* (Wulf.) J. Agh. are common in shallow waters along the coasts and reefs. Frequently great quantities are thrown up on the beaches by high tides or by kona storms. *U. fasciata* is known to the natives by the names *limu paha-paha* or *limu pala-haloha*. *U. lactuca* is called *limu lipa-laha-laha* or *limu pa-ka-ea*. These grow in quiet water near the shore and are easily gathered. When air dry these species have about 18 per cent water, 14 per cent protein, 50 per cent starches, sugars, etc., and 15 per cent ash. They are commonly used as a salad food by the natives, and comprise an important element in the food of the reef inhabiting fishes.

Enteromorpha flexuosa (Wulf.) Agh.—Very common on stones, along the shores and in the harbors; cosmopolitan.

E. Hopkirkii Agh.—An obscure species.

E. intestinalis (L.) Link.—Cosmopolitan, with numerous varieties and forms; abundant in Hawaiian waters.

E. Linza (L.) J. Agh.—Cosmopolitan, with several forms; abundant in Hawaiian waters.

E. plumosa Kuetz.—Cosmopolitan; not uncommon in Hawaii.

E. prolifera (Muell.) J. Agh.—Cosmopolitan; var. *tubulosa* Kuetz. occurs in brackish pools and ditches.

E. compressa (L.) Grev.—Cosmopolitan, with numerous varieties; var. *trichodes* Kuetz. is recorded from brackish situations.

All of the Hawaiian species of *Enteromorpha* grow in shallow salt or brackish waters along the coasts, and in brackish pools and ditches. They are usually abundant at the mouths of streams, especially on the islands of Kauai and Oahu. They are easily gathered, and are all considered edible by the natives. These algae, known as *limu ele-ele*, are among the most abundant, most popular, and most widely used of the edible algae. They are com-

monly on sale in the native markets. Chemical analyses of the air dry material show about 13 per cent water, 12–19 per cent protein, 50 per cent fats and carbohydrates exclusive of crude fiber, and 10–20 per cent ash.

ULOTHRICHIACEAE

Ulothrix subtilis Kuetz. and *U. minulata* Kuetz.—These two species are common in rice fields, taro patches, ditches, and similar situations; the yellow-green, decumbent, soft, hairlike fleece is attached to the bottom or rocks; under dripping water it forms a bright green incrustation.

CHAETOPHORACEAE

Stigeoclonium falklandicum Kuetz.—Called *limu pala-wai* or *limu li-pala-wai* by the natives, and used by them for food; occurs in streams and pools; fairly abundant.

S. amoenum Kuetz.—Called *limu hulu-ilio*; grows in brackish ponds and ditches near the sea; it is eaten by only a few of the natives; a cosmopolitan species with many varieties.

S. tenue Kuetz.—One of the algae most common on the vertical cliffs of waterfalls; in these situations it frequently becomes 12–14 inches long; like the preceding, it is a cosmopolitan species with many varieties.

Draparnaldia macrocladia Nordst.—Occurs in streams and pools; fairly common in Manoa, Nūuanu, Kalihi, etc.; endemic.

Aphanothece repens A. Br.—Occurs in taro patches, swamps, etc.; often epiphytic on such plants as *Cladophora*; also in most caverns, on the walls and floors, ex. Makiki Valley; a cosmopolitan species, occurring in Europe and New Zealand.

Chaetosphaeridium globosum (Nordst.) Klebahn.—Widely distributed in fresh water; thallus subglobose, of branched procumbent filaments.

OEDOGONIACEAE

Oedogonium obsoletum Wittr.—In brackish waters; also in Europe and North America.

O. globosum Nordst.—In streams; recorded only from Hawaiian Islands.

O. crispum var. *hawaiiense* Nordst.—In swamps and pools; a cosmopolitan species with numerous varieties.

O. Pringsheimii forma *pachydermatosporum* (Nordst.) Hirn.—Collected in the Mauna Kea swamplands; a cosmopolitan species with numerous varieties.

O. acrosporum var. *majusculum* Nordst.—Collected in the Mauna Kea swamps; another cosmopolitan species with numerous varieties.

O. longicolle Nordst.—In pools and ditches; there are several varieties in Hawaiian waters.

A number of the species of *Oedogonium* are plentiful in the mountain streams and in the vicinity of waterfalls.

Bulbochaete varians Wittr. var. *hawaiiensis* Nordst.—Widely distributed in temperate regions as well as in the tropics.

B. rectangularis Wittr. var. *hiloensis* Nordst.—Another widely distributed species with numerous local varieties.

COLEOCHAETACEAE

Coleochaete orbicularis Pringsh.—Thallus minute, orbicular, 2–3.5 mm. diameter; filaments numerous, articulate; cosmopolitan.

C. irregularis Pringsh.—Thallus irregular, bright green, filaments decumbent; cosmopolitan.

CLADOPHORACEAE

Chaetomorpha pacifica Kuetz.—Abundant along the shores; occurs in all tropical waters; filaments grass green, coarse and rigid.

Cladophora fracta (Dillw.) Agh.—In streams and damp caverns; a cosmopolitan species with numerous varieties.

C. inserta Dickie.—In brackish pools along the coasts.

C. Nordstedii DeT.—In pools and swamps of fresh water; rare.

C. composita Harv. and Hook.—Thallus pulvinate, spongiose, pale green; filaments delicate membranous, pellucid.

C. nitida Kuetz.—This species is called *limu hulu-ilio* (dog's hair) by the natives, and is sometimes used for food; it occurs in mountain streams and pools.

C. composita contracta Brand.—Found along the leeward shores of the island of Oahu.

C. Montagnei Waianeana Brand.—This and the preceding occur in shallow waters along the coral reefs; the species is Cuban.

C. antennina (Bory) Kuetz.—This and several other species are used locally by the natives for food, chiefly on the islands of Maui and Hawaii; they are called *limu hulu-ilio*, *limu ilio*, or *limu manu*.

BRYOPSISIDACEAE

Bryopsis plumosa Kuetz.—Plentiful in quiet shallow waters, on sandy bottoms, along the coral reefs; fronds 2–6 in. long, often highly pinnatifid.

CAULERPACEAE

Caulerpa pinnata (L.) Web.—Collected at Laysan Island.

C. racemosa var. *laetevirens* Web.—Collected at Laysan; there are several varieties; the species is known from the Red Sea.

C. laxifolia (Vahl.) Agh.—Plentiful along the leeward coral reefs in shallow waters and tidal pools, resembling a miniature *Lycopodium*; occurs throughout the Pacific and Indian oceans.

CODIACEAE

Halimeda tuna (Ell. and Sol.) Lam.—Abundant in the shallow waters along the coral reefs; a cosmopolitan species, and an important member of the reef-building series of algae.

H. opuntia (L.) Lam.—Has been collected at various points along the reefs and also at Laysan; a cosmopolitan species, with many varieties and forms. The reef-building powers of *Halimeda* and its associates have undoubtedly been underestimated in the past.

Codium adhaerens (Cabr.) Agh.—Thallus crustaceous, forming a sheet on the substratum, periphery excrescent; cosmopolitan.

C. tomentosum (Huds.) Stackh.—This and the preceding are called *limu aala-ula* by the natives; plentiful in shallow reef waters; thallus cylindric, elongate, dark green; cosmopolitan.

C. Muelleri Kuetz.—Known to the natives as *limu aala-ula*; on the island of Hawaii as *limu wawae-iole* and *limu wawae-moa*; it inhabits shallow coastal waters; often on exposed rocks in the surf, or on the outer margins of the reefs. The species of *Codium* all have stout holdfasts, and require a knife or chisel to collect them.

VALONIACEAE

Valonia aegagrophila (Roth) Agh.—Thallus irregularly tubular; cosmopolitan in all warm seas.

V. confervoides Harv.—Cosmopolitan in all warm seas; common in Hawaiian waters.

V. utricularis Agh.—Called *limu li-puu-puu* by the natives, and used by them for food; these species all live along the coral reefs, and are important fish food.

Dictyosphaeria favulosa (Agh.) Dcne.—Common along the reefs and coasts in shallow waters; also collected at Laysan.

Microdictyon umbilicatum (Velley) Zanard.—Leaflike, netted thalli; fairly common in pools and shallows along the reefs; a cosmopolitan species in all warm seas.

PITHOPHORACEAE

Pithophora affinis Nordst.—Native name *limu pala-wai* or *li-pala wai*; used for food; known only from the Hawaiian Islands.

CHARACEAE

Nitella havaiensis Nordst.—In streams, brackish ditches, and pools.

Chara coronata var. *leptosperma* forma *oahuensis* (Meyen) A. Br.—In ditches and pools.

C. gymnopus var. *armata* (Meyen) Nordst.—On all the islands, in ditches, shallow pools, etc.

ZYGNEACEAE

Mougeotia capucina (Bory) Agh.—Dark violaceous, in streams and pools; cosmopolitan, from Scotland to New Zealand.

Zygnema spontaneum Nordst.—In ditches, taro patches, rice fields, etc.; known only from the Hawaiian Islands.

Spirogyra is represented in the Hawaiian Islands by a number of species, abundant in streams and pools, both on the lowland and in the mountains; a number of them are used by the natives as food, and are called collectively *limu pala-wai*.

DESMIDIACEAE

The desmids are represented in the Hawaiian flora by the following known forms; there are undoubtedly very many forms as yet undescribed:

Desmidium aptogonium var. *acutius* Nordst., *Gymnozyga moniliformis* Ehrenb., *Gonatozygon Ralfsii* De Bary, *Cylindrocystis Brebissonii* Menegh., *Closterium didymotocum* var. *multinucleatum* Nordst., *C. praelongum* Breb., *C. Pritchardianum* Archer, *C. lineatum* var. *sandvicense* Nordst., *C. diana* Ehrenb., *C. parvulum* Naeg., *C. moniliferum* (Bory) Ehrenb., *C. setaceum* Ehrenb., *Penium lamellosum* Breb., *P. navicula* Breb., *Tetmemorus granulatus* forma *minor* Nordst., *T. levis* var. *continuum* Nordst., *Disphinctium palangula* (Breb.) Hansg., *D. subglobosum* (Nordst.) DeToni, *D. connatum* (Breb.) De Bary, *D. annulatum* Naeg., *D. speciosum* var. *simplex* Nordst., *Pleurotaenium trabecula* (Ehrenb.) Naeg., *P. Ehrenbergii* (Ralfs) Delp., *P. indicum* (Gren.) Lund., *P. nodulosum* (Breb.) De Bary, *Xanthidium armatum* var. *fissum* Nordst., *Cosmarium granatum* var. *subgranatum* Nordst., *C. Meneghini* Breb., *C. crenatum* Ralfs, *C. holmiense* Lund., *C. parvulum* Breb. forma *spetbergensis* Nordst., *C. sulcatum* Nordst., *C. depauperatum* Nordst., *C. anisochondrum* Nordst., *Arthrodesmus octocornis* forma *hawaiiensis* Nordst., *Euastrum binale* (Turp.) Ralfs, *E. ansatum* Lund., *E. sinuosum* Lenorm., *Micrasterias truncata* (Corda) Breb., *M. adscendens* Nordst., *Staurastrum subtile* Nordst., *S. spongiosum* var. *Griffithianum* (Naeg.) Lagerh., *S. subscabrum* Nordst., *S. muticum* Breb., *S. monticulosum* var. *duplex* Nordst., *S. margaritaceum* Ehrenb., *S. tenuissimum* West.

This gives a total of 15 genera and 47 known species.

FLAGELLATAE

The following flagellates have been collected in ditches, taro patches, rice fields, fishponds, and other quiet, shallow waters:

Salpincoeca pyxidium S.K., *Dinobryon sertularia* Ehrenb., *Euglena spirogyra* Ehrenb., *Phacus pyrum* (Ehrenb.) Stein., *P. pleuronectes* Nitzsch., *Trachelomonas volvocina* Ehrenb. var. *minuta* Lemm., *T. oblonga* Lemm. var. *truncata* Lemm., *T. hispida* (Perty) Stein.

SILICOFLAGELLATAE

Several species have been taken in plankton between Hawaii and Laysan, as follows:

Dictyocha fibula var. *messanensis* (Haeckel) Lemm., var. *stapedia* (Haeckel) Lemm., *Distephanus speculum* (Ehrenb.) Haeckel.

PERIDINIALES

A considerable number of forms in this group have been taken in plankton between Hawaii and Laysan:

Pyrocystis fusiformis Wyv., *P. pseudonoctulica* Wyv., *P. lunula* Schuett., *Hemidinium nasatum* Stein., *Pyrophacus horologium* Stein., *Ceratium candelabrum* (Ehrenb.) Stein., *C. furca* (Ehrenb.) Clap. and Lachm., *C. fusus* (Ehrenb.) Duj., var. *concauum* Gourr., var. *extensum* Gourr., *C. gibberum* Gourr., var. *contortum* Gourr., *C. gravidum* Gourr., *C. lineatum* Ehrenb., *C. tripos* (Mueller) Nitzsch., var. *arcticum* (Ehrenb.) Cleve., var. *arcuatum* Gourr., var. *horridum* Cleve., var. *macroceros* (Ehrenb.) Clap. and Lachm., *Gonyaulax polyedra* Stein., *G. polygramme* Stein., *Goniodoma armatum* (Schuett.) Schmidt., *Diplopsalis lenticula* Bergh., *Peridinium divergens* Ehrenb., var. *depressum* (Bail.) Cleve., var. *rhomboideum* Lemm., *P. inconspicuum* Lemm., *Oxytoxum Schauinslandii* Lemm., *Ceratocorys horrida* Stein., var. *longicornis* Lemm., *Phalacroma mitra* Schuett., *Amphisolenia palmata* Stein., *A. Schauinslandii* Lemm., *Histioneis quadrata* (Schuett.) Lemm., *H. Steinii* (Schuett.) Lemm.

BACILLARIALES

The diatons are represented by a large number of forms; like the desmids, the group is very incompletely known in tropical waters.

Melosira Juergensii Agh., *Gallionella nummuloides* (Dill) Bory, *Paralia sulcata* (Ehrenb.) Cleve., *Hyalodiscus subtilis* Bail., *H. scoticus* (Kuetz.) Grun., *Skeletonema costatum* (Grev.) Cleve., *Cyclotella striata* (Kuetz.) Grun., *Coscinodiscus excentricus* Ehrenb., *C. dimorphus* Castr., *Archnoidiscus ornatus* Ehrenb., *Asteropampa marylandica* Ehrenb., *A. rotula* Grev., *Aulacodiscus orientalis* Grev., *Pyrgodiscus calyciflos*. Temp. and Brun., *Actinocyclus ornatus* Rattr., *A. Ralfsii* (W.Sm.) Ralfs, *A. splendens* Rattr., *A. Ehrenbergii* Ralfs, *A. subtilis* (Greg.) Ralfs, *Guinardia elongata* Lemm., *Rhizosolenia semispina* Hensen., *R. setigera* Brightw., *R. styliformis* Brightw., *R. temperi* var. *acuminata* Perag., *Bacteriastrium varians* Lauder., *Chaetoceros diversum* var. *tenuis* Cleve., *C. lacinosum* Schuett., *C. peruvianum* Brightw., *Climacodium Jacobi* Cleve., *Triceratium arcticum* Brightw., *T. dubium* Brightw., *T. zonatula* Grev., *T. punctatum* Brightw., *T. Shadboldtianum* var. *robustum* Lemm., *Biddulphia pulchella* Gray, *B. reticulata* Roper, *B. imperialis* Walker, *Isthmia nervosa* Kuetz., *Isthmiella enervis* (Ehrenb.) Cleve., *Hemiaulus Hauckii* Grun., *H. delicatus* Lemm., *Terpisnoe musica* Ehrenb., *T. australis* Ehrenb., *Rhabdomena adriaticum* Kuetz., *R. robustum* Grun., *Tabellaria platystoma* Ehrenb., *T. rhabdostoma* Ehrenb., *Climacosira mirifica* (W.Sm.) Grun., *Striatella deliculata* (Kuetz.) Grun., *Grammatophora marina* (Lyngb.) Kuetz., var. *communis* Grun., var. *macilenta* W.Sm., *G. havaiensis* Mereschk., *G. angulosa* Ehrenb.,

var. hamulifera (Kuetz.) Grun., *Gephyria media* Arnott, *Opephora pacifica* (Grun.) Petit., *Licmomorpha flabellata* (Carm.) Agh., *L. remulus* Grun., *L. Ehrenbergii* var. *tenuistriata* Mereschk., *L. dubia* Grun., *L. Grunowii* var. *elongata* Mereschk., *L. Juergensii* Agh., *Climacosphenis moniligera* Ehrenb., *C. elongata* Mereschk., *Fragilaria capucina* Desmaz., *F. lamella* Ehrenb., *Rhaphoneis setaces* Ehrenb., *Synedra ulna* var. *splendens* (Kuetz.) Brun., *S. acus* Kuetz., *S. radians* Kuetz., *S. pulchella* (Ralfs) Kuetz., *S. affinis* Kuetz., var. *sandwicensis* Grun., *Ardissonia fulgens* (Grev.) Grun., *A. superba* (Kuetz.) Grun., *A. robusta* (Ralfs) DeToni, *Toxarium undulatum* Bail., *T. semilunare* Lemm., *T. Hennedyanum* (Greg.) Grun., *T. rostratum* Hantz., *Asterionella formosa* Hass., *A. notata* Grun., *Eunotia pectinalis* (Kuetz.) Rabenh., *Acthnanthes glabrata* (Grun.) Cleve., *A. lanceolatum* Breb., *A. brevipes* var. *angustata* Grev., var. *pennaeformis* Grev., *Campyloneis Grevellei* W.Sm., var. *typica* Cleve., *Cocconeis pellucida* Hantzsch., *C. pseudomarginata* Greg., var. *intermedia* Grun., *C. heteroidea* Hantzsch., var. *sigmoides* Grun., *Caloneis liber* var. *linearis* Grun., var. *genuina* forma *tenuistriata* Cleve., *C. formosa* Greg., *Diploneis papula* A.S., *D. splendida* Greg., *D. Schmidtii* Cleve., *D. Weisflogii* A.S., *D. notabilis* Grev., *D. vacillans* A.S., *D. nitescens* Greg., *D. crabo* var. *multicostata* Grun., var. *minuta* Cleve., *Navicula cuspidata* var. *ambigua* Ehrenb., *N. pupula* Kuetz., *N. confervacea* Kuetz., *N. anceps* var. *obtusa* Grun., *N. cryptocephala* Kuetz., *N. rhyncocephala* Kuetz., var. *amphiceros* Kuetz., *N. consors* A.S., *N. cancellata* var. *Gregorii* Ralfs, *N. Zostereti* Grun., *N. brasiliensis* Grun., *N. concilians* Cleve., *N. Hennedyi* var. *tahitensis* Cleve., *Trachyneis aspera* Ehrenb., var. *pulchella* W.Sm., *T. antillarum* var. *Mereschk* Cleve., *T. velata* A.S., *Pinnularia appendiculata* Agh., *P. interrupta* forma *stauroneiformis* (V.H.) Cleve., *P. divergens* W.Sm., *P. borealis* Ehrenb., *P. stauoptera* var. *interrupta* Cleve., *P. acrosphaeria* forma *maxima* Cleve., *P. major* Kuetz., *P. viridis* Nitzsch., *Pleorosigma balticum* (Ehrenb.) W.Sm., *P. formosum* W.Sm., *P. rigidum* W.Sm., *P. angulatum* W.Sm., *Tropidoneis lepidoptera* var. *samoensis* Grun., *Mastogloia decussata* Grun., *M. fimbriata* Brightw., *M. minuta* Grev., *M. exigua* Lewis, *M. Goesii* Cleve., *M. citrus* Cleve., *M. pumila* Grun., *M. quinquecostata* var. *concinna* A.S., *M. electa* A.S., *Gomphonema parvulum* Kuetz., *G. gracile* var. *dichotomum* W.S., *G. lanceolatum* Ehrenb., *G. subclavatum* Grun., *G. olivaceum* var. *tenellum* Kuetz., *Rhiocosphenia curvata* (Kuetz.) Grun., *Amphora ovalis* (Breb.) Kuetz., var. *pediculus* (Kuetz.) V.H., *A. coffaeiformis* Agh., *A. lineolata* Ehrenb., *A. angusta* var. *eblongella* Grun., *Rhopalodia gibba* (Ehrenb.) O.M., *R. musculus* (Kuetz.) O. Mueller, *R. gibberula* var. *minuens* O. Mueller, var. *Vanheurckii* O. Mueller, var. *minuta* O. Mueller, *Nitzschia panduriformis* Greg., var. *minor* Grun., *N. subcostata* Grun., *N. Janischii* Grun., *N. angularis* W.Sm., *N. sigmoidea* (Nit.) W.Sm., *N. vermicularis* (Kuetz.) Hant., *N. sigma* (Kuetz.) W.Sm., var. *intercedens* Grun., var. *rigidula* Grun., var. *curvula* (Ehrenb.) Grun., *N. obtusa* var. *nana* Grun., *N. linearis* (Agh.) W.Sm., *N. palea* (Kuetz.) W.Sm., *N. ventricosa* Kitton, *N. lorenziana* var. *major* Grun.,

N. curvirostris Cleve., var. *closterium* (Ehrenb.) V.H., *N. acuclaris* (Kuetz.) W.Sm., *N. longissima* (Breb.) Ralfs, *N. pungens* Grun., var. *atlantica* Cleve., *Surirella fastuosa* Ehrenb., *S. anfractosa* A.Sc., *Podocystis adriatica* Kuetz., *Campylodiscus Grevillii* Leud.-Fortm., *C. kittonianus* Grun.

Phaeophyceae

ECTOCARPACEAE

Ectocarpus simpliciusculus var. *vitiensis* Asken.—Along the coasts; often on other algae, for example, *Turbinaria*; also collected at Laysan.

E. indicus Sonder.—Plentiful along the coasts, in shallow waters; called *limu aka-akoa* or *limu hulu-ilio* by the natives, and in common use by them as food.

E. paradoxus Mont.—Common along the coasts and reefs.

SPHACELARIACEAE

Sphacelaria tribuloides Menegh.—Common in shallow waters along the coast.

S. furcigera Kuetz.—Fairly abundant in pools and shallow waters along the reefs.

ENCOELIACEAE

Hydroclathrus cancellatus Bory.—Abundant in shallow waters along the coral reefs; forms a stiff, olive-brown, perforated cushion, several inches in diameter.

Asperococcus bulbosus Lam.—Frequent in quiet shallows along the coast.

FUCACEAE

Turbinaria ornata J. Agh.—Abundant along the outer margins of the reefs, where it is exposed to the full force of the surf; also in deeper offshore waters; often cast up on the beaches in great quantities after storms.

T. vulgaris J. Agh.—Habitat as for the preceding, but not so abundant.

Sargassum obtusifolium J. Agh.—Known only from the Hawaiian Islands.

S. polyphyllum J. Agh. and var. *fissifolium* Grun.—Known only from these islands.

S. densum Dickie.—Known only from leeward Oahu; Honolulu Harbor.

S. incisum Dickie.—Known only from leeward Oahu; Honolulu Harbor.

S. echinocarpum J. Agh.—Recorded only from Hawaii and Fiji.

S. cymosum Agh.—Widely distributed in the Pacific and Atlantic oceans.

The species of *Sargassum* are all known as *limu kala* by the natives, and are used for food. They are probably the most abundant and widely distributed of the larger algae in the Hawaiian Islands. They grow in the shallow waters along the reefs, on stones and submerged ledges, and on the reefs themselves. In many restricted localities, for example, the leeward shores of Oahu, Kauai, and Molokai, they are more abundant than any other seaweed. The native uses have been described by REED as follows:

Limu kala is sometimes broken into small pieces and soaked in fresh water until it turns dark and soft, then stuffed into salmon before it is roasted, or it is chopped with fish heads and salt. It is sometimes ripened by putting in water with a few mollusks called *leho*, salted slightly, and allowed to stand for several days before eating. *Limu kala* is more often than any other limu eaten on the beach, without any preparation other than rinsing off the sand and breaking into convenient pieces for eating with raw fish or squid. It is also sometimes put into meat gravies or stews just as it is served.

DICTYOTACEAE

Stypopodium lobatum Kuetz.—Occurs in many parts of the Pacific and Atlantic; collected at Laysan; thallus at first decumbent, later ascending; flabellate, palmatifid or lobate, concentrically zoned.

Padina Commersonii Bory.—Frequent in shallow water within the lagoons, often on muddy bottom; widely distributed in the Pacific and Atlantic oceans.

P. Pavonia (L.) Gaill.—Abundant along the coral reefs, in pools and lagoons; often growing where the water is distinctly muddy and brackish; gregarious and forming extensive colonies; occurs in many parts of the Atlantic and Pacific; called *limu pepeiao*.

Haliseris plagiogramma Mont.—Foliose parts flat, costate, dichotomous; grows far out on the outer margins of the reefs, where the heavy surf breaks, also in rather deep water. It occurs in other tropical and subtropical waters of the Atlantic and Pacific, for example, West Indies and Australia. It usually can be gathered only by diving or swimming. It grows here and there in small quantities only, on all the islands. It is a choice delicacy among the natives, who call it *limu lipoa*. It is often pounded and mixed with other seaweeds to give them its peculiar, penetrating, spicy flavor and odor. It is frequently served with meats or put into the gravy or stews to give them a peppery flavor, of which the Hawaiians are very fond. All Hawaiians like the odor and flavor of this alga, especially with raw fish. It is considered particularly delicious with raw flying fish, if simply broken and salted slightly.

H. pardalis Harv.—A very rare species, occasionally washed ashore after storms; also occurs in Australian waters; fronds linear, dichotomous.

Dictyota acutiloba J. Agh. and var. *distorta* J. Agh.—Recorded only from the Hawaiian Islands.

D. sandvicensis (Sond.) Kuetz.—Fairly abundant; also found in Australian waters, Red Sea, and Indian Ocean.

D. spinulosa Harv.—Rare; in various parts of the North Pacific.

D. dichotoma (Huds.) Lamx.—Common; widely distributed in all oceans.

The species of *Dictyota* are all called *limu alani* by the Hawaiians, but are seldom used for food, as they possess a bitter flavor.

ARTHROCLADIACEAE

Chnoospora pannosa J. Agh.—Fronds in a dense caespitose tangle, blackish, 6–10 cm. high, much branched and interwoven; reported only from the Hawaiian Islands.

C. fastigiata pacifica J. Agh.—Called by the natives *limu wawahi-wa'a* or *limu kau-pau*, and used as food; occurs in various parts of the Pacific, and also along the Atlantic shores of South America; fronds caespitose with numerous dichotomously branching fastigiate branches, color dark olive.

Rhodophyceae

BANGIACEAE

Porphyra leucosticta Thuret.—This is the famous *limu lua'u* of the Hawaiians, a very highly prized delicacy. It appears in late winter or early spring after the heavy southerly storms, and lasts for only a few days. It is found only on exposed rocks constantly dashed by the waves, so it is difficult and dangerous to collect, especially as the alga is extremely slippery and has to be scraped forcibly from the rocks in small bunches while the collector clings to his support and avoids the heavy waves. REED states as follows:

He must be sure-footed, quick, and a good swimmer, if he collect *limu lua'u*. . . . It is prepared by washing in the usual way in fresh water. It is then salted a little and put into clear water, where it becomes slippery and colors the water a lovely violet color. Sometimes *opihii*, a kind of limpet, is put in with the limu and salt in water, and placed in bottles or jars. This is used as needed, for it keeps many weeks when placed in the weak brine with the limpets.

Limu lua'u is considered a great delicacy in the few localities where it occurs, but it lasts so short a season, is so scarce, and so difficult to get that it is not very widely known. Only on northern Kauai, northern Maui, and northern Hawaii is it in use or in great favor, as it does not occur in other places, except a few scattered plants on Oahu and Molokai.

HELMINTHOCLADIACEAE

Liagora valida Harv.—Collected at Laysan; also occurs in the Atlantic and around Madagascar; often calcareous.

L. coarctata Zanard.—Collected at Laysan.

L. decussata Mont.—Called *limu pu-aki* by the natives, and considered edible; grows along the coral reefs in quiet shallow water, often in mud or sand or on small stones; fronds filiform, virgate-ramified, calcareous.

CHAETANGIACEAE

Galaxaura lapidescens (Soland) Lamx.—Fronds cylindrical or compressed, subtubular, incrustated with lime; along the coral reefs in shallow waters; a common species in warm seas.

G. spongiosa Kuetz.—Habitat same as the preceding.

Scinaia furcellata (Turn.) Biv. and var. *undulata* (Mont.) J. Agh.—Fronds solitary or clustered, arising from a disklike base, several times dichotomous; cosmopolitan, with several varieties.

Actinotrichia rigida (Lamx.) Descne.—Widely distributed in the Pacific and Indian oceans, and in the Red Sea.

GELIDIACEAE

Gelidium attenuatum (?).—Name used by REED; not listed by DETONI; probably a synonym.

G. corneum (?).—Name used by REED; not listed by DETONI; probably a synonym.

G. felicinum Bory.—Occurs in the Pacific Ocean.

G. intricatum (Agh.) Kuetz.—Listed as occurring in Hawaiian waters; according to DETONI an obscure species.

G. latifolium Born.—Cosmopolitan; abundant in Atlantic and Adriatic; common in Hawaiian waters.

G. cartilagineum (L.) Gaill.—In the Pacific and Atlantic oceans.

G. pusillum (Stackh.) Le Jol.—A cosmopolitan species.

The species of *Gelidium* are all called *limu loloa*, sometimes *limu ekaha-kaha*, by the natives, and are extensively used for food. They grow on exposed black lava rocks, near the tide line, in rough water, where they are constantly washed by the surf. They have tenacious holdfasts, and require a knife or chisel for collecting. These algae are abundant along the rocky shores of Kauai, Oahu, and Molokai, and also occur in considerable quantities on the other islands. They produce a dark, viscid gelatine, strongly flavored, but suitable for glue manufacture. REED states that "our species of *Gelidium* are undoubtedly as gelatinous as the Japanese species, but they are not nearly so plentiful."

Wrangelia penicillata Agh.—This beautiful, delicate, olive green, fernlike species inhabits tidal pools along the reefs and rocky shores; cosmopolitan.

Pterocladia capillacea (Gmel.) Bornet.—Uncommon; used by the natives of Kauai and Maui, and known by them as *limu loloa*; occurs also in Mediterranean and Atlantic.

GIGARTINACEAE

Gigartina papillata (Agh.) J. Agh.—Fronde flat, simple or apparently dichotomous, segments truncate-cuneate; recorded only from the Hawaiian Islands and the Golden Gate.

Gymnogongrus vermicularis americana J. Agh.—A cosmopolitan species.

G. disciplinarius (Bory) J. Agh.—Recorded from various parts of the Pacific.

These algae are generally called *limu ua-ua-loli* by the natives, but there are also a number of other native names: *limu ekaha-kaha*, *limu ko-ele-ele*, *limu awiki-wiki*, *limu nei*. They grow far out on the coral reefs, along the outer margin, where the surf is heavy. All have tough, strong holdfasts. They are most abundant on Maui and Molokai, and are rather scarce in Hawaii.

Abnfeltia concinna J. Agh.—Native name *limu aki-aki* or *limu eleau*. A succulent, brittle, reddish brown alga, abundant on partially submerged lava rocks along the coasts. It shows a preference for exposed black lava rocks, in rough water, where it receives the heavy surf. It occurs in large quantities in these habitats along the shores of Kauai, Oahu, and Hawaii, and is plentiful here and there in a few localities on the other islands. Sometimes it grows in quiet coves or behind lava ledges in less exposed places. This seaweed is relished by the natives and is commonly sold in the markets. Its air dry composition is, roughly, water 20 per cent, protein 5 per cent, starches, sugar, etc., 55 per cent, crude fiber 3 per cent, ash 15 per cent. In the fineness and clarity of its gelatine this alga is exceeded only by *Gracilaria coronopifolia*.

A. Durvillaei (Bory) J. Agh.—Recorded from various parts of the Pacific.

RHODOPHYLLIDACEAE

Eucheuma nudum J. Agh.—Fronde terete, subcompressed, dichotomously branched; recorded only from the North Pacific.

SPHAEROCOCCACEAE

Sphaerococcus coronopifolius (Good. and Wood.) Agh.—Fronds dichotomously branched; fairly common; also occurs in many parts of the Pacific and Atlantic.

Gracilaria coronopifolia J. Agh.—This species is called *limu manauea*, and is extensively used for food by the Hawaiians. It grows in shallow water along the reefs, on sandy bottoms, and in stormy weather often drifts ashore in considerable quantities. It is plentiful along the low beaches of leeward Kauai, Oahu, and Molokai. Because of the less favorable coasts, it is not abundant on Maui, and less so on Hawaii. The season of greatest abundance is spring and early summer, although it is fairly plentiful throughout the year. It is one of the limus commonly offered for sale in the native fishmarkets. Its air dry composition is, roughly, water 12 per cent, protein 8 per cent, starches, sugars, etc., 58 per cent, crude fiber 3 per cent, and ash 17 per cent. It makes fine clear gelatine of excellent quality, and requires less cooking for its preparation than do the other algae.

G. confervoides (L.) Bory.—Widely distributed in all oceans; fronds long, terete, much branched; edible, but not common.

Hypnea nidifica. J. Agh.—Intricately caespitose, expanded; known from various parts of the Pacific Ocean.

H. armata (Mert.) J. Agh.—Elongate; corymbosely branched. This and the preceding species are known as *limu huna* and are among the most commonly eaten of the Hawaiian seaweeds. They are especially relished by the natives when boiled with octopus. They are abundant along the coral reefs, in shallow waters, and often drift ashore in considerable quantities. The species of *Hypnea* are common on Kauai, Oahu, and Molokai; scarce on Maui, and very rare on Hawaii. They are outranked by both *Gracilaria* and *Ahnfeltia* in the quality and quantity of their gelatine.

RHODOMENIACEAE

Plocamium sandvicense J. Agh.—Known only from the Hawaiian Islands, leeward shores of Oahu; fronds pinnately decomposed, very beautiful.

Champia compressa Harv.—Fronds branched, tubular, nodose, purple, gelatinous, membranous; known to the Hawaiians as *limu o-olu*; common along the reefs, both in shallow water and farther out. Its distribution is very irregular. Also in the South Pacific and African waters.

Chylocladia rigens (Agh.) J. Agh.—Edible, called *limu akuila* or *limu kihe*; common in many parts of the Pacific.

DELESSERIACEAE

Martensia flabelliformis Harv.—Plentiful in shallow waters along the reefs; fronds flat, dichotomous, with eccentric subimbriate lobes; also recorded from Samoa.

BONNEMAISONIACEAE

Asparagopsis Sanfordiana Harv.—A very delicate plant, resembling a miniature pink conifer. It grows far out along the margins of the reefs, in the shallow waters where the surf breaks. It has a number of Hawaiian names, *limu kohu* being the most common. On Maui, Molokai, and Kauai it is often called *limu lipa-akai* or *limu lipehu*. REED states that it is always pounded well as it is being cleaned, to free it from adhering bits of coral, and also that the subsequent soaking may the more thoroughly remove the disagreeable bitter flavor. It is soaked 24 hours or more in fresh water, to remove the bitter iodine flavor. It is then salted ready to be served as a relish or salad with meats, fish, or poi, or it is mixed with other seaweeds and put into hot gravy and meat stews. *Limu kohu* has a pleasant, although slightly bitter, flavor. It is sold in the form of balls about the size of a large baseball; the price is usually 25 cents per ball; it is always in great demand. At Moloaa, on the island of Kauai, a crude kind of culture of *limu kohu* is carried on. The natives have cleared out all of the other seaweed from the reef, so that the *Asparagopsis* does not suffer from competition, and is here much finer and more luxuriant than at any other place.

RHODOMELACEAE

Laurencia nidifica J. Agh.—Reported only from the Hawaiian Islands.

L. papillosa (Forst.) Grev.—Abundant; widely distributed in all seas.

L. obtusa (Huds.) Lamx.—Frequent; a cosmopolitan species.

L. vaga Kuetz.—According to DETONI probably a form of *perforata*.

L. pinnatifida (Gmel.) Lam. and var. *osmunda* Lam.—Reported.

L. perforata Mont.—Frequent; also in the tropical Atlantic.

L. virgata (Agh.) J. Agh.—Rare; in Pacific and African waters.

The species of *Laurencia* are known to the Hawaiians by various names; *limu maneo-neo* for the shorter, coarser species, *limu li-pee-pee* for the finer, longer forms. *Limu lipee* is a contracted phrase; *limu li-puu-puu*, a name used locally in certain districts on Maui and Hawaii. The species of *Laurencia* grow in shallow waters along the reefs, either on sandy bottom, or in rocky places. They are frequently washed ashore in considerable quantities by high tides or stormy weather. The natives use all the species for food, and the prepared *limu* may be purchased in the fishmarkets.

Chondria tenuissima var. *intermedia* Grun.—Called *limu o-olu* by the natives, who use it for food; abundant on the broad, shallow, sandy bottomed inshore waters of Kauai, Oahu, and Molokai; easily gathered. It prefers quiet water and rarely grows in places exposed to the surf. Common in the fishmarkets.

Polysiphonia tongatensis Harv.—According to DETONI probably a synonym for *P. mollis*.

P. polyphysa Kuetz.—According to DETONI probably a synonym for *P. ferulacea*.

P. ferulacea Suhr.—Common; widely distributed in all oceans.

P. mollis Hook. and Harv.—Called *limu pu-alu* or *limu hawane* by the natives; it is not popular, and is seldom used as food.

Amansia glomerata Agh.—The beautiful dark red rosettes of this alga are common in deep shady pools and crevices in the coral reef; Hawaiian names are *limu li-pepe-iao* or *limu pepe-iao*, and the natives use it for food.

CERAMIACEAE

Griffithsia ovalis Harv. (?).—A very rare species; sometimes used for food on Maui and southern Hawaii; called *limu moo-puna*, *limu ka-lipoa*, and *limu au-pupu*.

Ceramium clavulatum Agh.—Known by a number of native names; *limu hulu-ilio*, *limu hulu*, and *limu hulu wawae-iole*; abundant in shallow waters, within the reefs, growing on sandy bottoms, and easily gathered.

C. Kuetzingianum Grun.—Fronds minute, thin, branched; epiphytic on other seaweeds; also occurs in the South Pacific.

GRATELOUPIACEAE

Halymenia formosa Harv.—Rare; native name *limu lepeahina*; fronds gelatinous, flat, stipitate, much branched; also occurs in the South Pacific.

Grateloupia filicina (Wulf.) Agh.—Abundant in shallow waters within the reef; on sandy bottom and on rocks. Known to the Hawaiians as *limu paka-ele-awa'a* or *limu hulu-hulu-waena*; the former name is used exclusively on Kauai, the latter on Hawaii; both names are used on the intermediate islands. This alga also occurs in many other seas.

SQUAMARIACEAE

Peyssonnelia rubra Descne.—In shallow waters along the reefs, in company with such algae as *Halimeda Opuntia*; adherent to the substratum; sometimes calcareous; in many other seas.

CORALLINACEAE

Mastophora tenuis Descne.—Reported only from the Hawaiian Islands.

Amphiroa fragilissima (L.) Lamx.—Collected at Laysan; also abundant in the Indian Ocean, and along the shores of Peru.

Corallina sandvicensis Reinbold.—Collected at Laysan; fronds 4-5 cm. high; known only from Laysan.

The coralline algae have not been worked up taxonomically; there are probably 15 or 20 species in addition to the preceding.